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## USN Norfolk Naval Shipyard

Norfolk, Virginia  
CERCLIS #VA1170024813

### ■ Site Exposure Potential

The Norfolk Naval Shipyard (NNSY) is a 530-hectare facility in Portsmouth, Virginia extending 3.25 km north of Paradise Creek on the Southern Branch of the Elizabeth River, approximately 24 river km from Chesapeake Bay (Figure 1). The NNSY began operations as a merchant shipyard in 1767 and is the oldest continuously operated shipyard in the United States. Table 1 lists major source areas and associated hazardous materials. The NNSY surrounds Atlantic Wood Industries, Inc. (AWII), a former wood treating facility that is being remediated under the authority of CERCLA (Figure 2; Baker Environmental Inc. 1997). NOAA did not have any information about the St. Helena Annex portion of NNSY,

which is on the east side of the Southern Branch of the Elizabeth River.

The NNSY is located on relatively flat land, approximately 3 m above mean sea level. Surface runoff and shallow groundwater flow from higher site areas into Paradise Creek and the Southern Branch of the Elizabeth River. The water table is 1.5 m to 0.3 m below ground surface (bgs). Mean tidal range at the site is approximately 1 m (Baker Environmental Inc. 1997).

Surface water runoff, groundwater transport, and soil erosion are potential sources of contaminant transport to Paradise Creek and the Southern

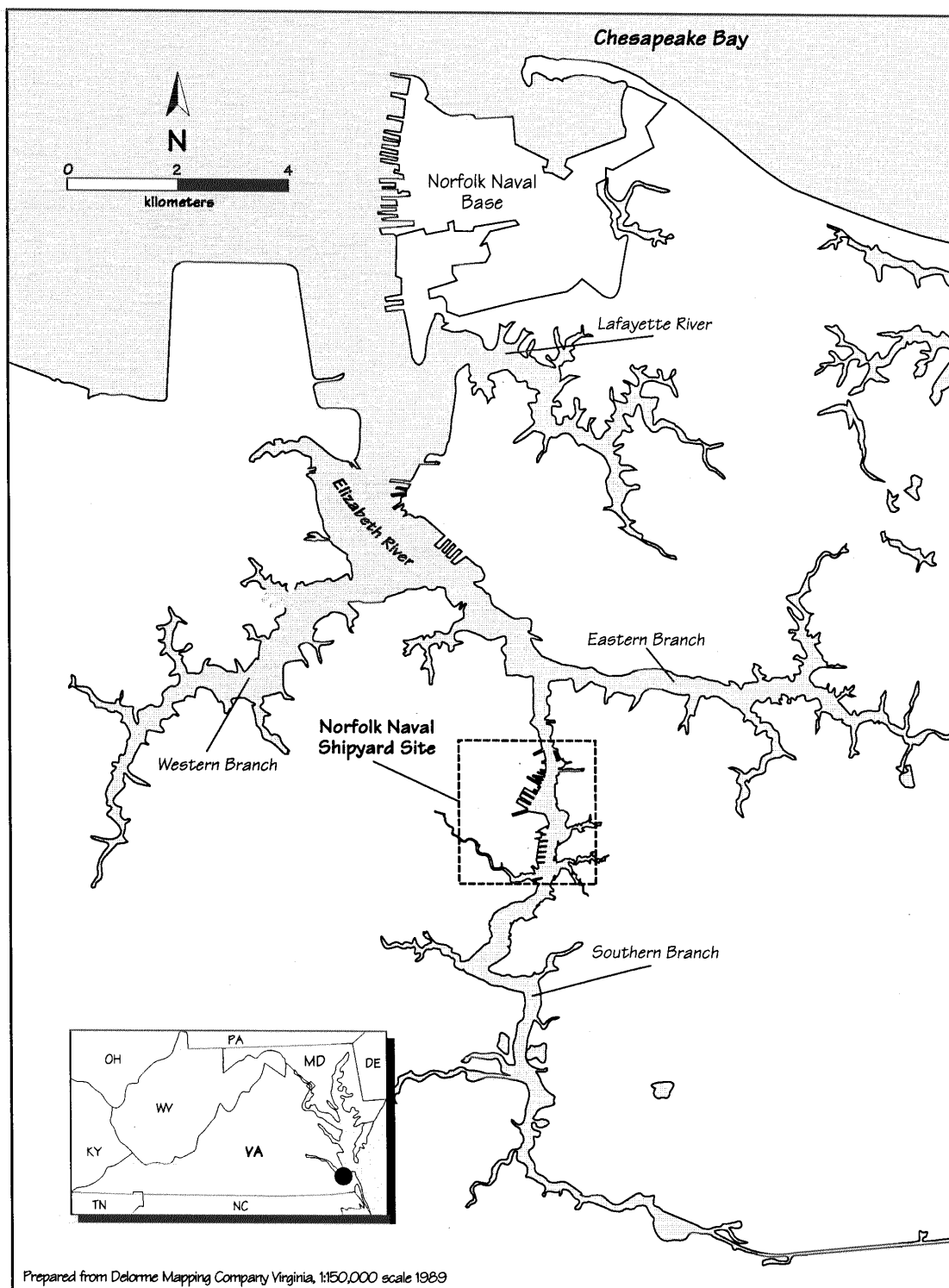


Figure 1. Norfolk Naval Shipyard study area.

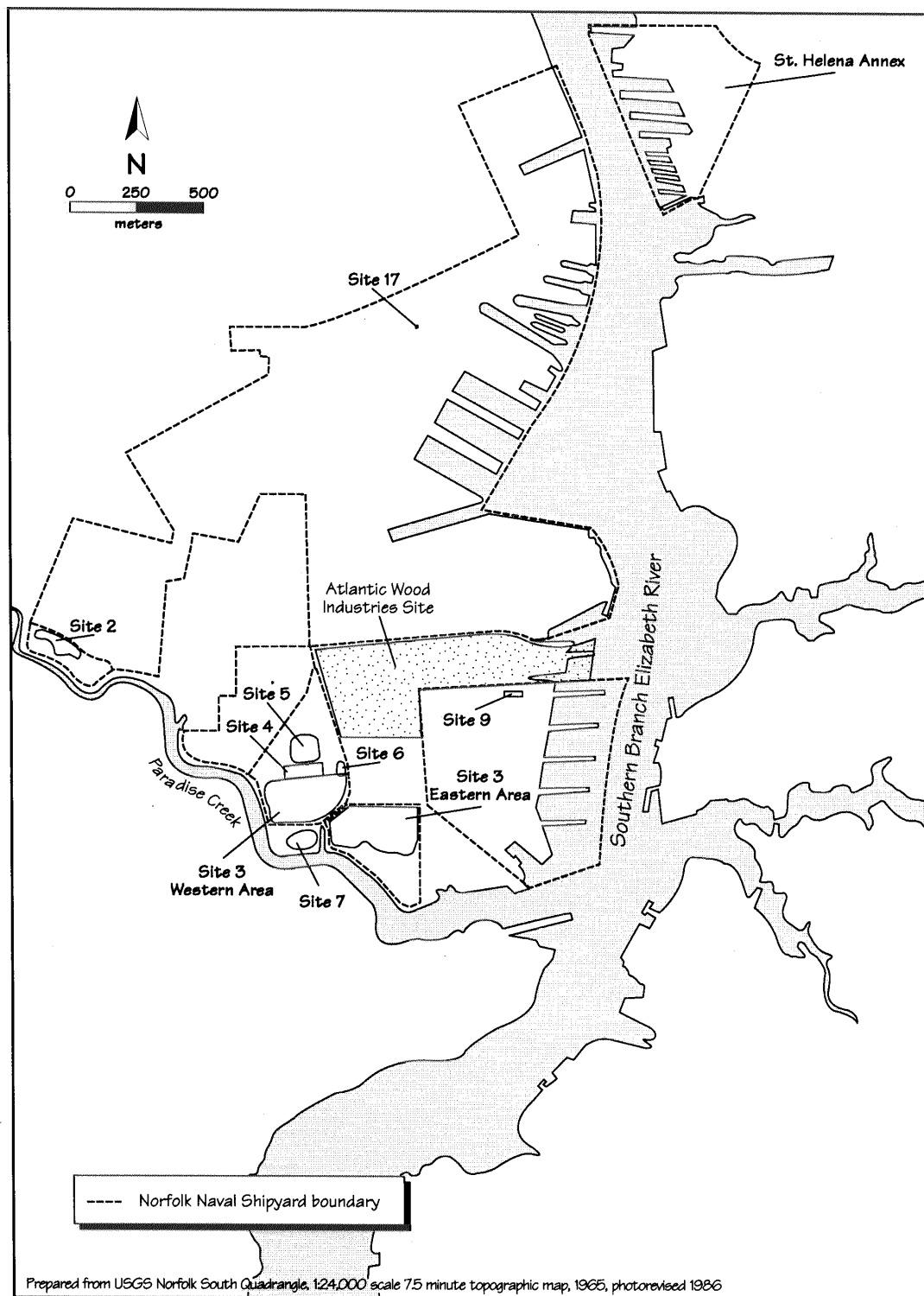


Figure 2. The Norfolk Naval Shipyard site in Portsmouth, Virginia

Table 1. Norfolk Naval Shipyard Site Descriptions.

Site No.	Site Description	Dates Used	Materials Deposited
2	Scott Center Landfill	Unknown	Drydock wastes, including abrasive blast media, paint residues, sanitary waste, and other industrial residues.
3	Sanitary Landfill	1954 - Present	Salvage waste, abrasive blast grit, boiler fly and bottom ash, industrial wastewater treatment plant sludge, and other wastes.
4	Chemical Disposal Pits	Approx. 1963 - 1978	Chemical wastes including cyanides, acids, degreasers, solvents, alkali, and other toxic wastes.
5	Oil Reclamation Area	Approx. 1963 - 1982	Waste petroleum oil lubricants.
6	Chemical Disposal Pits	Mid - 1960s - 1977	Chemical wastes including cyanides, acids, degreasers, solvents, alkali, and other toxic wastes.
7	Bermed Disposal Area	Approx. late 1960s to late 1970s	Unknown. Same material as listed for Sites 4 and 6 is suspected.
9	Waste Lime Pit	Approx. 1942-1971	Waste lime.
17	Building 195 (Electroplating)	Late 1800 - present	Electroplating chemical spills, coal pile residue, and leachate.

Branch of the Elizabeth River (Baker Environmental Inc. 1997).

The site was proposed for inclusion on the U.S. EPA National Priority List on March 6, 1998 (63 FR 11340). Groundwater, surface water, soil, and sediment recently were sampled for an ecological risk assessment (CH2M Hill 1998).

## ■ NOAA Trust Resources and Habitats

Habitats of concern to NOAA are surface waters and associated bottom substrates of Paradise Creek, the Southern Branch of the Elizabeth River, and downstream areas of Chesapeake Bay (Figure 1). Anadromous fish, estuarine fish, and invertebrates are the resources of concern (Table 2). Estuarine habitats in this area range from shallow sand/mud flats and tidal streams less than 1 m deep to trenches up to 13 m deep

(USGS 1964, 1965). Salinities range from 14 to 20 parts per thousand and sediments range from silts to sands. Riparian wetlands are located along the southern and western sections of NNSY, adjacent to Paradise Creek (Majumdar et al. 1987).

Trawl surveys by the Virginia Institute of Marine Science (VIMS) indicate that the Southern Branch of the Elizabeth River provides habitat for numerous estuarine and marine fish species. Year-round residents include bay anchovy, oyster toadfish, sheepshead minnow, killifishes, silver-sides, pipefish, gobies, and hogchoker (VIMS 1989). All life stages of these species are spent within the estuary and several of the species are highly abundant. Other species, such as bluefish, mullets, pinfish, butterfish, and the sciaenids (croaker, weakfish, seatrout, spot, and drum) spawn offshore in coastal waters. These species migrate to the estuary as juveniles, where they may spend several years foraging and maturing.

**Table 2. NOAA trust fish and invertebrate species that use the Elizabeth River, Hampton Roads, and Chesapeake Bay.**

Species		Habitat Use			Fisheries	
Common Name	Scientific Name	Spawning Ground	Nursery Ground	Adult Forage	Comm. Fishery	Recr. Fishery
<u>ANADROMOUS/CATADROMOUS SPECIES</u>						
Alewife	<i>Alosa pseudoharengus</i>		♦			
American eel	<i>Anguilla rostrata</i>		♦		♦	
American shad	<i>Alosa sapidissima</i>		♦			
Blueback herring	<i>Alosa aestivalis</i>		♦			
Striped bass	<i>Morone saxatilis</i>		♦	♦	♦	
White perch	<i>Morone americana</i>		♦	♦		
<u>MARINE/ESTUARINE FISH SPECIES</u>						
Atlantic croaker	<i>Micropogonias undulatus</i>		♦	♦		♦
Atlantic herring	<i>Clupea harengus</i>		♦	♦		
Atlantic menhaden	<i>Brevoortia tyrannus</i>		♦	♦		
Bay anchovy	<i>Anchoa mitchilli</i>		♦	♦		
Black drum	<i>Pogonias cromis</i>		♦	♦		
Black sea bass	<i>Centropristis striata</i>		♦	♦		
Bluefish	<i>Pomatomus saltatrix</i>		♦	♦		♦
Butterfish	<i>Peprilus triacanthus</i>		♦	♦		
Cownose ray	<i>Rhinoptera bonasus</i>		♦	♦		
Gobies	<i>Gobiosoma</i> spp.	♦	♦	♦		
Hogchoker	<i>Trinectes maculatus</i>	♦	♦	♦		
Killifish	<i>Fundulus</i> spp.	♦	♦	♦		
Mullet	<i>Mugil</i> spp.		♦			
Northern pipefish	<i>Syngnathus fuscus</i>	♦	♦	♦		
Northern searobin	<i>Prionotus carolinus</i>		♦			
Pinfish	<i>Lagodon rhomboides</i>		♦	♦		
Red drum	<i>Sciaenops ocellatus</i>		♦	♦		♦
Red hake	<i>Urophycis chuss</i>		♦			
Oyster toadfish	<i>Opsanus tau</i>	♦	♦	♦		
Scup	<i>Stenotomus chrysops</i>		♦			
Spotted seatrout	<i>Cynoscion nebulosus</i>		♦	♦		♦
Sheepshead minnow	<i>Cyprinodon variegatus</i>	♦	♦	♦		
Silversides	<i>Menidia</i> spp.	♦	♦	♦		
Skates	<i>Raja</i> spp.		♦	♦		
Spot	<i>Leiostomus xanthurus</i>		♦	♦		♦
Summer flounder	<i>Paralichthys dentatus</i>		♦	♦		♦
Tautog	<i>Tautoga onitis</i>		♦	♦		
Weakfish	<i>Cynoscion regalis</i>		♦	♦		
Windowpane flounder	<i>Scophthalmus aquosus</i>		♦	♦		
<u>INVERTEBRATE SPECIES</u>						
Bay shrimp	<i>Crangon septemspinosa</i>	♦	♦	♦		
Blue crab	<i>Callinectes sapidus</i>	♦	♦	♦	♦	♦
Blue mussel	<i>Mytilus edulis</i>	♦	♦	♦		
Eastern oyster	<i>Crassostrea virginica</i>	♦	♦	♦		♦
Grass shrimp	<i>Palaemonetes pugio</i>	♦	♦	♦		
Northern quahog	<i>Mercenaria</i> spp.	♦	♦	♦		♦

Even as adults, these migratory species are found within the estuary seasonally. Bluefish, spot, and Atlantic croaker are particularly abundant in the area (Stone et al. 1994).

Several anadromous fish species use the estuary during part of their life cycle. Juvenile and adult white perch are abundant in the estuary, and spawn in tidal freshwater reaches upstream of the site. Striped bass, particularly juvenile stages, are common in the Southern Branch of the Elizabeth River. Adult striped bass may spend time in the area as well, but most probably move seaward (Stone et al. 1994). American shad, blueback herring, and alewife also spawn in freshwater upstream of the site (VIMS 1989). Atlantic sturgeon are considered rare near the site and in Chesapeake Bay. No threatened or endangered fish species have been observed near the site. The catadromous American eel is found throughout the Chesapeake basin, with juvenile life stages present near the site (Stone et al. 1994).

Blue crab, grass shrimp, eastern oyster and northern quahog also are common in the estuary. Both juvenile and adult blue crab are abundant. After mating in estuarine waters, female blue crab usually migrate offshore to brood and release eggs. The larvae and juvenile stages migrate back onshore to mature in the estuary. All life stages of grass shrimp, oyster, and quahog are found within the estuary (Stone et al. 1994).

Hampton Roads, near the Elizabeth River outlet in Chesapeake Bay, supports substantial commercial and recreational fisheries. Popular recre-

ational catches are bluefish, croaker, spot, weakfish, flounder, blue crab, oyster, and quahog (Majumdar et al. 1987). Commercial landings from the Elizabeth River for 1996 were over 100,000 kg. Most of this harvest was blue crab. American eel and striped bass also are harvested in significant quantity (O'Reilly 1998). The Virginia Department of Health restricts bivalve harvests surrounding the shipyard as well as at the Norfolk Naval Base near the mouth of the river (Wright 1998).

## ■ Site-Related Contamination

Elevated concentrations of trace elements and organic compounds, including PAHs, VOCs, and SVOCs, have been measured in groundwater, surface water, soil, and sediment from NNSY and nearby portions of Paradise Creek and the Elizabeth River (Huggett et al. 1987; Baker Environmental Inc. 1994; Foster Wheeler 1994; Baker Environmental Inc. 1997; CH2M Hill 1997, 1998).

The maximum concentrations of trace elements in all media were found in the western and southern portions of NNSY, including Paradise Creek. In these areas, maximum reported concentrations of copper, lead, mercury, and zinc exceeded applicable guidelines by at least an order of magnitude. Mercury in Paradise Creek sediment exceeded the ERL by more than three orders of magnitude (Table 3).

The western and southern portions of the site and Paradise Creek also had high concentrations of organic compounds. In surface water, the highest measured concentrations of the PAH compounds acenaphthene, naphththalene, 2-methyl-naphthalene, and phenanthrene were in Paradise Creek. However, the highest organic contaminant concentrations in soil and groundwater were predominantly on eastern NNSY, near the Southern Branch of the Elizabeth River. Maximum sediment concentrations of the PAH compounds anthracene, fluorene, fluoranthene, and pyrene, were from Southern Branch samples. The highest sediment concentrations relative to guidelines were for anthracene and fluorene, also in samples from the Southern Branch. Sediment samples from both Paradise Creek and the Southern Branch had high concentrations of pesticides (Table 3).

## ■ Summary

Concentrations of trace elements and organic chemicals much greater than screening guidelines have been measured in groundwater, surface water, soil, and sediment at NNSY. Maximum trace element concentrations were found in the western and southern portions of the site, and adjacent Paradise Creek. Maximum reported PAH concentrations in sediments were in the Southern Branch of the Elizabeth River. Substantial populations of anadromous fish, estuarine fish, and invertebrates use habitats in the Southern Branch of the Elizabeth River and Paradise

Creek. There are important commercial and recreational fisheries next to the site and downstream of the site in the Chesapeake Bay.

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**Table 3. Maximum concentration of contaminants of concern found at the Norfolk Shipyard (Huggett et al. 1987; Foster Wheeler 1994; Baker Environmental Inc. 1994; Baker Environmental Inc. 1997; CH2M Hill 1997, 1998).**

	Water (µg/l)			Soil (mg/kg)			Sediment (mg/kg)		
	Ground-Water	Location	Surface Water	AWQC <sup>a</sup>	Soils	Location	Mean U.S. <sup>b</sup>	Sediment	Location
<b>Trace Elements</b>									ERL <sup>c</sup>
Arsenic	342	Site 3	123	36	303	Site 2	5.2	52.7	PC
Cadmium	35.4	Site 3	5.5	9.3	57.2	Site 3	0.06	4	PC
Chromium	356	Site 3	163	50	664	Site 3	37	284	PC
Copper	5520	Site 3	657	2.9 <sup>e</sup>	72700	Site 3	17	1390	PC
Lead	4370	Site 3	2700	8.5	46640	Site 7	16	593	PC
Mercury	23.9	Site 9	1.2	0.025 <sup>d</sup>	12.3	Site 3	0.058	886	PC
Nickel	1440	Site 3	452	8.3	2600	Site 3	42	247	PC
Selenium	40.4	Site 3	13.6	71	14.5	Site 2	NA	3.7	PC
Silver	15	Site 3	4	0.92 <sup>p</sup>	52.9	Site 3	0.05	3	PC
Zinc	7900	Site 3	1460	86	30400	Site 3	48	3000	PC
<b>Organic Compounds</b>									
Acenaphthylene	10	Site 3	5.0	NA	2.9	Site 9	NA	2.7	ER
Acenaphthene	60	Site 3	60	NA	36	Site 9	NA	1186	ER
Anthracene	18	Site 3	18	NA	310	Site 9	NA	27.2	ER
Benz(a)anthracene	10	Site 3	5.0	NA	150	Site 9	NA	2	PC
Chlordane	0.1	Site 2	0.028	0.0043	0.011	Site 7	NA	0.014	PC
Chrysene	10	Site 3	5.0	NA	8	Site 7	NA	3.5	ER
DDT	0.1	Site 2	0.050	0.001	8.8	Site 3	NA	0.012	PC
DDE	0.1	Site 2	0.050	NA	18	Site 3	NA	0.180	PC
Dibenz(a,h)anthracene	10	Site 2	5.0	NA	0.550	Site 3	NA	0.34	PC
Dieldrin	0.1	Site 2	0.050	0.0019	0.130	Site 3	NA	0.009	PC
Endosulfan	0.1	Site 9	0.025	0.087	0.0095	Site 3	NA	0.038	PC
Endrin	0.1	Site 2	0.050	0.0023	0.034	Site 3	NA	1.8	PC
Fluoranthene	24	Site 3	11	NA	17	Site 9	NA	27.300	ER
Fluorene	42	Site 9	28	NA	51	Site 3	NA	24.530	ER
Heptachlor	0.1	Site 2	0.025	0.0036	0.007	Site 2	NA	0.007	PC
Heptachlor Epoxide	0.1	Site 2	0.025	0.0036	0.0083	Site 3	NA	0.011	PC
2-Methylnaphthalene	59	Site 3	59	NA	31	Site 9	NA	0.815	ER
Naphthalene	460	Site 9	83	NA	40	Site 9	NA	14	PC
PCBs (as Aroclors)	1	Site 3	0.500	0.03	21	Site 3	NA	0.160	PC
Pentachlorophenol	25	Site 2	12.5	7.9	3.3	Site 2	NA	3.5	PC
Phenanthrene	75	Site 9	75	NA	270	Site 9	NA	5.85	ER
Pyrene	10	Site 2	8	NA	270	Site 9	NA	18.5	ER
Toxaphene	5.0	Site 2	2.5	0.0002	6.6	Site 3	NA	0.700	PC
<b>a: Marine chronic ambient water quality criteria for the protection of aquatic organisms, unless noted otherwise (EPA 1993).</b>									
<b>b: Average trace element concentrations in U.S. soils (Shacklette and Boerngen 1984), except for cadmium and silver which are average concentrations in the earth's crust (Lindsay 1979).</b>									
<b>c: Effects Range-Low: The 10th percentile concentration for the dataset in which effects were observed or predicted as compiled by Long et al (1995)</b>									
<b>d: Criterion expressed as total recoverable metal.</b>									
<b>e: Chronic criterion not available; acute criterion presented.</b>									
<b>p: Proposed criterion.</b>									
<b>NA: Screening guidelines not available.</b>									
<b>PC: Paradise Creek (no specific location given unless noted otherwise).</b>									
<b>ER: Elizabeth River</b>									



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